Science Requirements for GBX Investigation
SHERE
SHear Extensional Rheology Experiment

Objective

- To study the effect of pre-shear on the transient evolution of the microstructure and viscoelastic tensile stresses for monodisperse dilute polymer solutions.

Hardware Requirements

- Generate a smooth, bubble-free, cylindrical liquid bridge (5x10∅ mm ±5%) between 2 flat endplates.
- Impose homogeneous shear rate in fluid by rotating one of the endplates in the range $0 \le \Omega \le 500$ rpm ±1% and holding other plate stationary. Achieve target angular velocity within 100ms; stop rotation within 10ms of starting elongational deformation.
- Impose an approximately homogeneous elongational deformation in the fluid by axially translating one endplate in an exponential manner to generate strain rates (ε') in the range $0.1 \le \varepsilon' \le 5.0\ s^{-1}$ obtaining maximum Hencky strains in the range $3.5 \le \varepsilon \le 4.5$.
- Conduct tests within the temperature range $20 \le T \le 25\ ^{\circ}C$ ($68 \le T \le 77\ ^{\circ}F$). Control/minimize temperature fluctuations during each series of tests on the same fluid sample to within ±1.0 °C. *Desired* to control the environment temperature such that all tests begin at the same temperature ±0.5 °C

Measurement Requirements

- Axial force ('thrust') induced due to shearing and stretching the elastic fluid within range $|F| \le 10^4$ dyne ±50 dyne. (= 10 ± .05 grams-force).
- Actual axial displacement of the translation stage (0–20 cm range)
- Axial midplane diameter of fluid filament ($0.1 \le D \le 10$mm, ±0.005mm)
- Temperature T of the fluid
- Video of fluid filament profile evolution (resolution TBD; adequate to accurately detect edges and measure axial profile $D(z)$ of the fluid column)

Test Matrix

- 5 test series spanning strain rates $0.1 \le \varepsilon' \le 5.0\ s^{-1}$, each series conducted with 5 pre-shear rates in the range $0 \le \Omega \le 500$ rpm.
- Minimum of 9 tests required for minimum science return; 25 tests for complete success

The SHERE Glovebox Investigation has 25 test points. The 25 test points consist of 5 series of tests (I – V) each with a different stretch rate. Within each series, there are 5 different pre-shear rates. A minimum of 9 complete test points is required for minimum scientific success, as depicted in the shaded areas of Table 1.

Table 1

SHERE Glovebox Investigation Test Matrix					
	Stretch Rate				
	I ($0.1\ s^{-1}$)	**II ($0.3\ s^{-1}$)**	**III ($1.0\ s^{-1}$)**	**IV ($3.0\ s^{-1}$)**	**V ($5.0\ s^{-1}$)**
Pre-Shear Rate	**0.0**	0.0	**0.0**	0.0	**0.0**
	1.0	1.0	1.0	1.0	1.0
	10.0	10.0	**10.0**	10.0	**10.0**
	30.0	30.0	30.0	30.0	30.0
	50.0	50.0	**50.0**	50.0	**50.0**

- Minimum Science Test Matrix is shaded areas
- Pre-Shear Rotation Rate, Ω = (Pre-Shear Rate)(L_o/R_o)($60/2\pi$), L_o=5mm, R_o=5mm
- Stretch Velocity, $V(t) = (L_o)(\text{Stretch Rate})e^{(\text{Stretch Rate})t}$
- Final Stretch Velocity, $V_f = (40)\ (L_o)(\text{Stretch Rate})$

Post-Flight Data Deliverables for SHERE

The following deliverables will be supplied by NASA to the GI for post flight analysis:

- Time synchronized Labview data of axial force as a function of experiment time
- Time-synchronized axial displacement of the translation stage
- Time synchronized Labview data of fluid filament midpoint diameter as a function of experiment time
- Time-synchronized fluid temperature, T, as a function of experiment time
- Time-synchronized digital or hi-resolution analog video images of fluid filament profile evolution as a function of experiment time
- Any other engineering parameters recorded or videotaped during the experiment will be desired